

January 26, 2012

Marlene H. Dortch  
Secretary  
Federal Communications Commission  
445 Twelfth Street, SW  
Washington, DC 20554

Re: *Amendment of Part 27 of the Commission's Rules to Govern the  
Operation of Wireless Communications Services in the 2.3 GHz Band (WT  
Docket No. 07-293) WRITTEN EX PARTE PRESENTATION*

Dear Ms. Dortch:

Recently, the WCS Coalition submitted to the Commission a report, "Simulation of TD-LTE User Equipment Transmissions in the WCS Band" by Jim O'Connor and Kurt Schaubach, in support of the WCS industry's call for the Commission to reconsider and reverse the imposition of a 50 mW/MHz power spectral density ("PSD") limit on WCS mobile devices (the "Report").<sup>1</sup> The Report discusses in detail how LTE technology dynamically allocates spectrum among mobile devices and sets mobile power levels on a frame-by-frame (*i.e.*, millisecond) basis. Most significantly, the Report presents the result of simulations which demonstrate that, notwithstanding the fact that LTE mobile transmissions may on rare occasion exceed the 50 mW/MHz PSD limit, power from a given mobile device tends to be evenly distributed across the WCS band when viewed over an appropriate period of time. These simulations establish that under real world operating conditions, the 50 mW/MHz PSD limit is not necessary to prevent harmful interference to Sirius XM subscribers. To supplement the Report, the WCS Coalition is submitting the accompanying presentation by Mr. O'Connor, which addresses in detail the manner in which the simulations underlying the Report were conducted utilizing software developed for use in cellularized network planning.

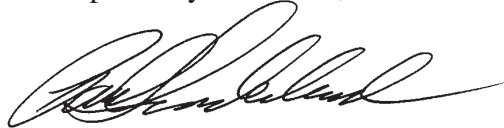
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<sup>1</sup> See Letter from Paul J. Sinderbrand, Counsel to the WCS Coalition, to Marlene H. Dortch, Secretary, Federal Communications Commission, WT Docket No. 07-293, Attachment (dated Dec. 1, 2011).

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Pursuant to Sections 1.1206(b)(2) and 1.49(f) of the Commission's Rules, this letter is being filed electronically with the Commission via the Electronic Comment Filing System. Should you have any questions regarding this presentation, please contact the undersigned.

Respectfully submitted,

A handwritten signature in black ink, appearing to read 'Paul J. Sinderbrand', written in a cursive style.

Paul J. Sinderbrand

Counsel to the WCS Coalition

Attachment

cc: Rick Kaplan  
Julius Knapp  
Mindel De La Torre  
John Leibovitz  
Ronald Repasi  
Patrick Forster  
Tom Peters  
Roger Noel  
Linda Chang  
Paul Moon  
Moslem Sawez  
Stephen Duall  
Chip Fleming

# Summary of the Simulation Model Used in “Simulation of TD-LTE User Equipment Transmissions in the WCS Band”

WCS Coalition  
January 24, 2012

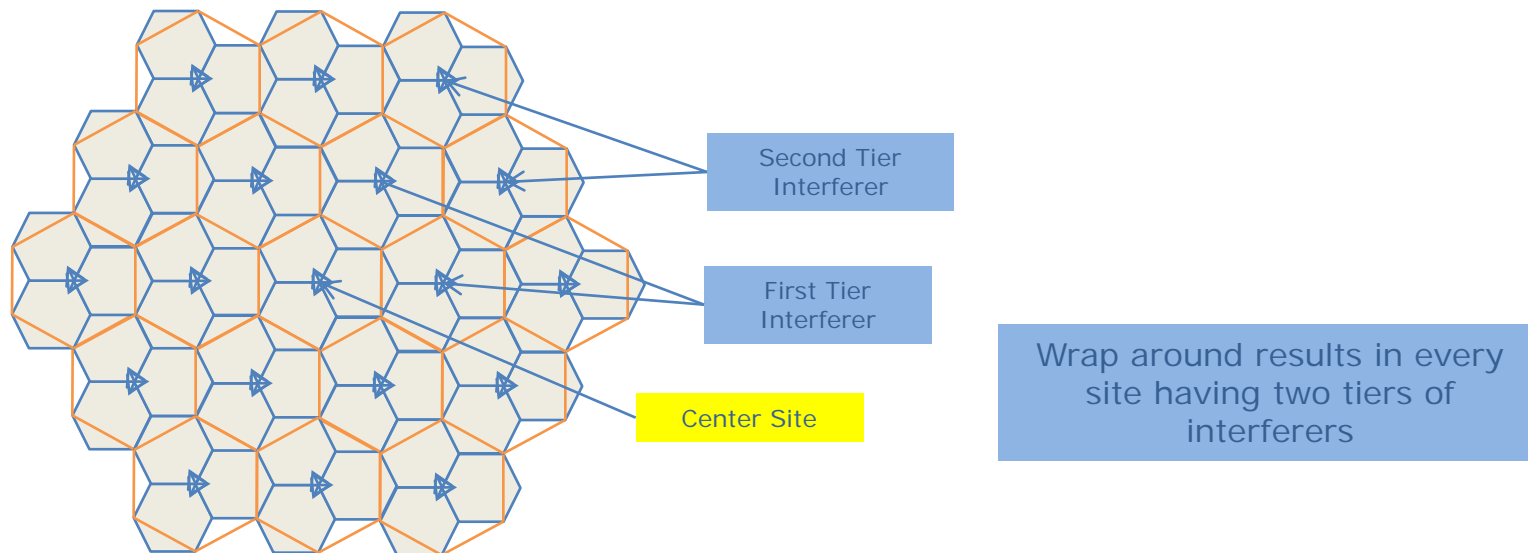
# Overview

- This presentation describes the simulation methodology used to produce the Physical Resource Blocks (PRB) distribution and uplink (UL) transmit power statistics provided in the WCS Coalition White Paper “Simulation of TD-LTE User Equipment Transmissions in the WCS Band” (WCS Coalition White Paper) submitted to the FCC on December 1, 2011.
- LTE system level simulations were used to develop estimates of the UL transmit power spectral density of an LTE mobile device (UE) under different radio and traffic conditions.
- The simulation platform used had initially been developed for purposes of commercial cellular network planning. Therefore, the assumptions used in the simulation are representative of real world conditions in a commercial LTE network.
- The simulation platform was developed using Matlab and C++.
  - The main OO (object oriented) frame work is built on Matlab, whereas lower level functions, such as those related to PHY receiver, link adaptation, scheduler, etc. are build on C++.
  - For run time, the Matlab code is compiled and the simulation is run on a Linux cluster with 148 processing nodes. This allows for massive parallelization of the simulation during run time.

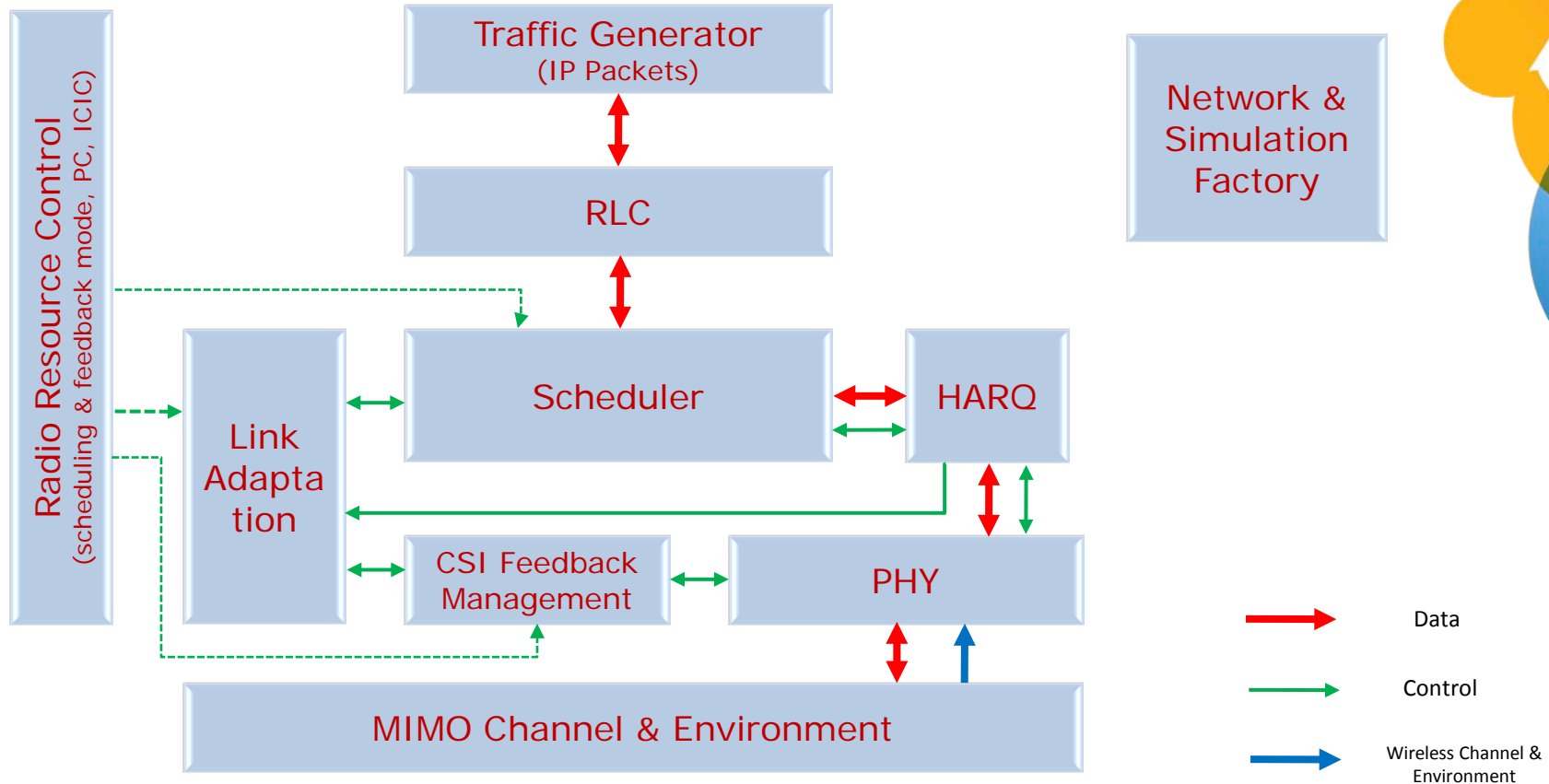


# Overview of the Simulator

- The basic network model consist of 19 three-sectored sites with a wrap-around.
- Wrap around is used to ensure that each sector observes 2 tiers of interference and therefore provides realistic simulation results.
- Results shown in the WCS Coalition's White Paper are derived from user equipment (UE) connected to the Center Site shown below.
- Antenna Model:
  - » 3GPP 2D and 3D antenna model for the eNodeB and omni directional model for the UE are the default choices.
  - » However, any specific antenna pattern and response for eNodeB and UE can be incorporated in the channel model.
- Dynamic Interference Model:
- Multipath fading of the interfering signal:
  - » ITU channel models
  - » Spatial channel models (SCM) - provides a much better understanding of the performance of a real system
- Varying precoder (single or multi-layer beamforming) and transmission rank
- Scheduling decision based on offered load, link conditions, proportional-fair allocations.



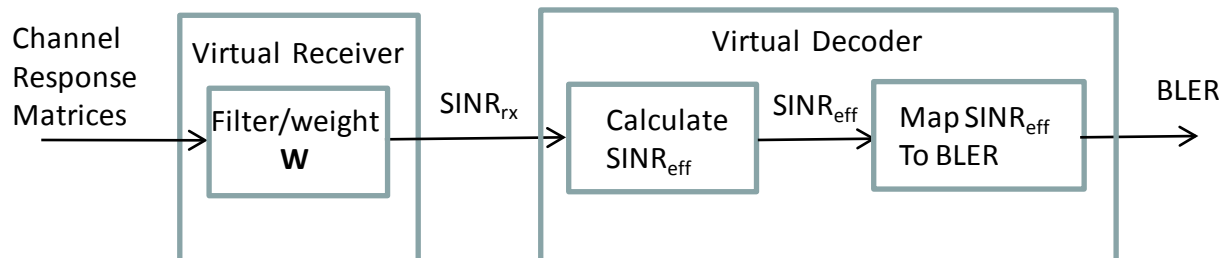
# Components of System Level Simulator



The simulator input from the Link Adaptation modules uses Channel State Information (CSI) and other physical channel information to inform the scheduler during PRB allocation so that each UE is assigned optimal PRBs for each allocation. Channel multipath effects result in channel bandwidth-wide distribution of PRBs assigned to each user over time.

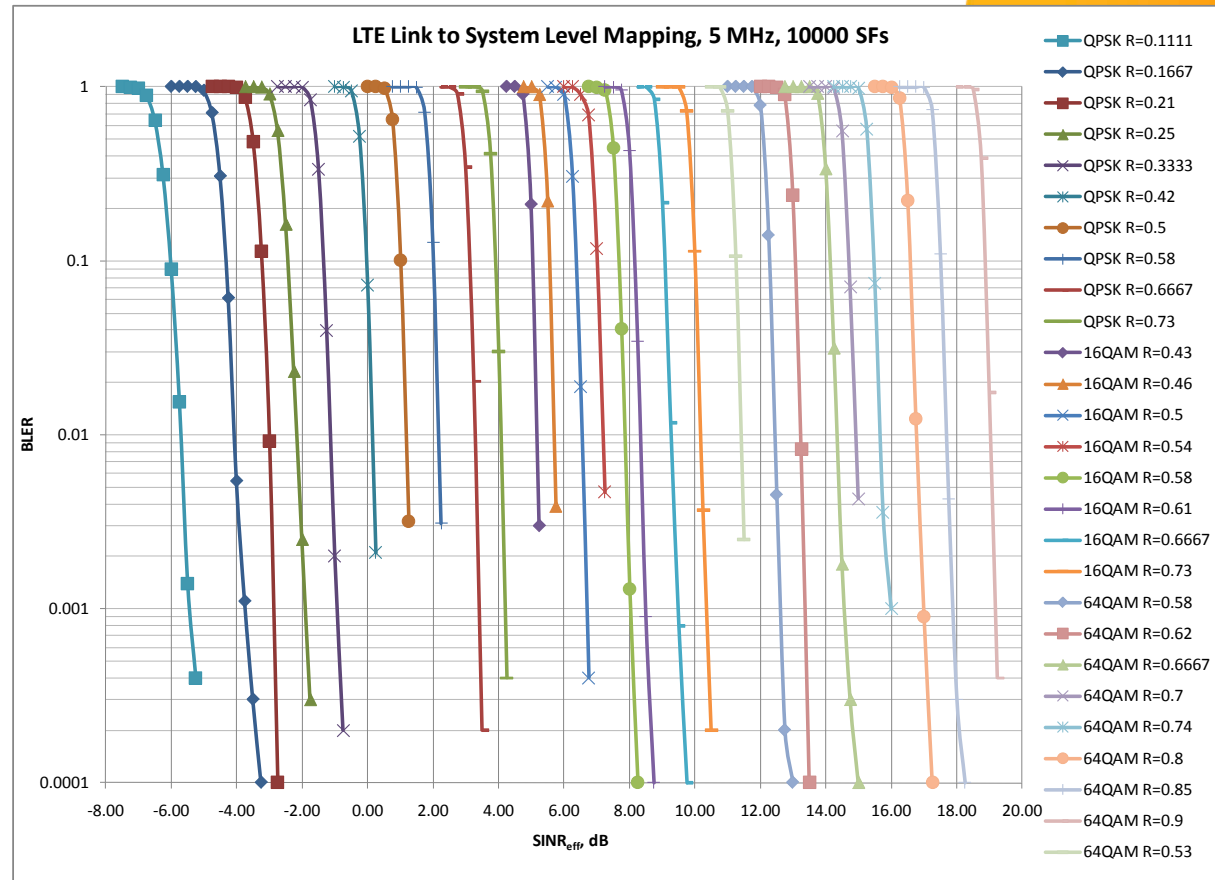
# Link-to-System Level Mapping

- At the lowest layer (PHY layer) of the simulator the entire system is modeled at the signal to interference noise ratio (SINR) level. Based on the receiver abstraction, the SINR is computed for each resource element (RE) in the time frequency grid. In the interest of simulation speed, each RE is not sampled in the entire time frequency grid. Rather, a certain degree of decimation is used.
- Virtual Receiver develops a set of signal to interference noise ratios ( $\text{SINR}_{\text{rx}}$ ) based upon the input channel response matrices and the type of receiver processing, e.g. linear Minimum Mean Squared Error (MMSE). In LTE, the set of  $\text{SINR}_{\text{rx}}$  values span the time-frequency grid corresponding to a sub-frame, which is 1 ms in duration and consists of 14 OFDM symbols. In the limit, there is one  $\text{SINR}_{\text{rx}}$  for every sub-carrier.
- Virtual Decoder processing consists of two stages:
  - A single effective SINR =  $\text{SINR}_{\text{eff}}$  (also referred to as the AWGN equivalent SINR) is computed using a technique referred to as the Mutual Information Effective SINR Metric (MIESM)
  - A symbol level MEISM map that was developed in-house was used.
  - The  $\text{SINR}_{\text{eff}}$  is mapped to a block error rate (BLER) using a comprehensive set of BLER versus SINR curves which span the modulation and coding scheme (MCS) range of interest. Finally, a Bernoulli coin toss is then performed based upon this value of BLER to determine if the block is in error.



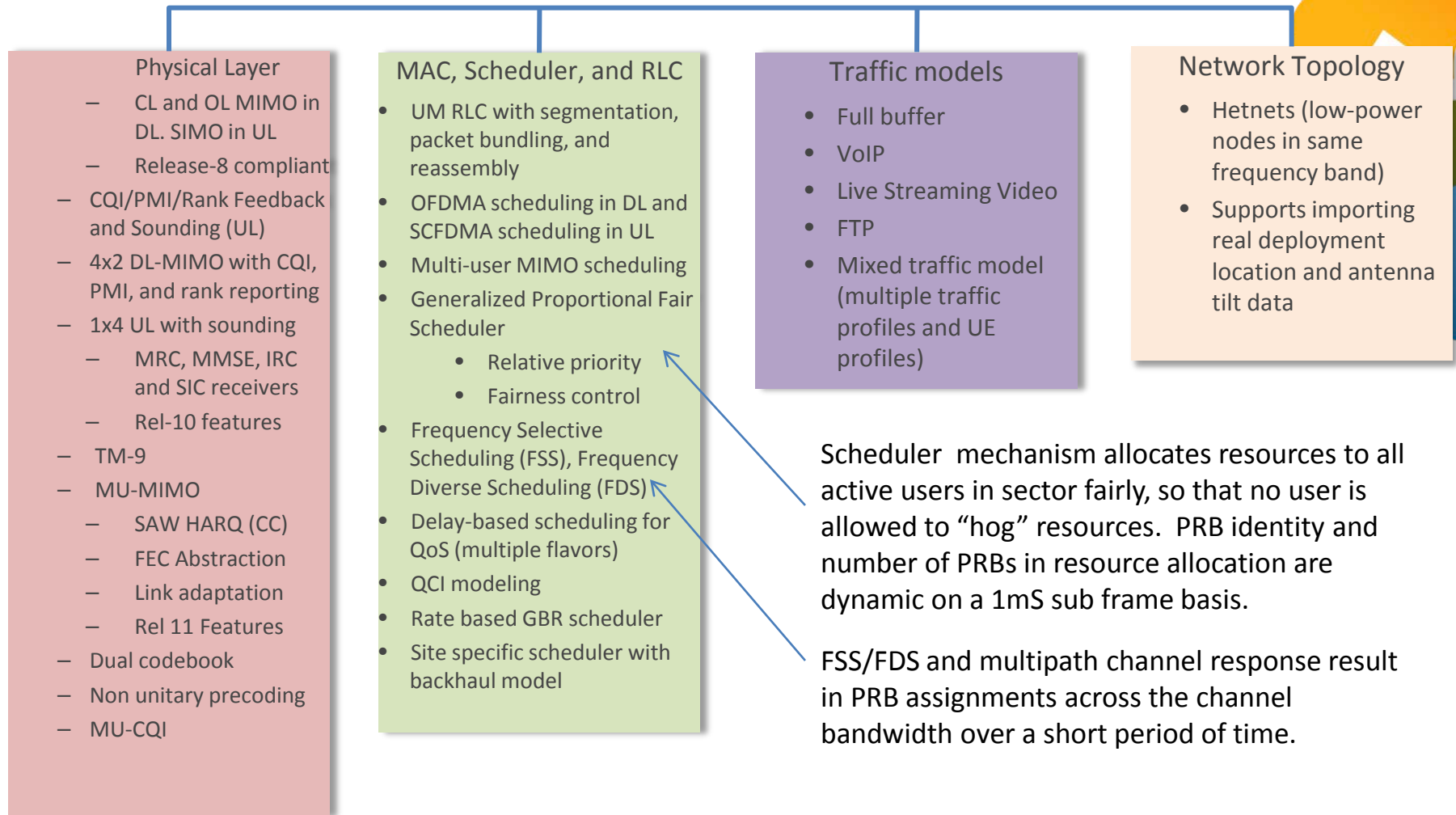
# Link Level Curves (SINR to BLER)

- Once the SINReff is calculated, it is used to estimate the block error probability based on link level simulations in an AWGN noise environment.
- This implies that the block error probability as a function of SINReff needs to be tabulated for each of the MCSs of interest.
- However, one does not need to do this process separately for all the different multi-path profiles, receiver types, MIMO configuration, since all of those details are taken care of while calculating the SINReff for each data block.





# System-Level Simulator Capabilities



# Simulation Assumptions for UL PSD Analysis

Carrier Frequency	2305 MHz
Channel Bandwidth	10 MHz
Duplexing	FDD
Traffic Model	30 MB file download (5 UE/sector) Streaming video 500 kbps (10 UE/sector)
Network Model	19 site (57 sector) with Wrap Around
Propagation Model	COST 231 SubUrban
Multipath Channel Model	Spatial Channel Model Enhanced (SCME)
Shadow Fading	8dB std dev with spatial correlation
Base Station Height	30 m
Base Station Antenna	Cross pol antenna with 70° horizontal beamwidth and 12° vertical beamwidth
BS Antenna Gain	17dBi
Cell Radius	1 km
UE Transmit Power	23dBm
Power Control	Open Loop and Closed Loop
UE Antenna	Omni directional cross pol
UE Antenna Gain	-3dBi
Scheduling	Proportional Fair with no QoS (SCFDMA)
Link Adaptation	Realistic based on UL Sounding
Channel Estimation	Realistic based on dm-RS
# of HARQ Process	8
Max Transmission per HARQ	6
HARQ Delay	8 msec
Target BLER for 1st HARQ	10%
RLC	UM with in sequence delivery
Receiver Implementation Margin	1.5 dB
UI Transmitter EVM	8%

## Notes:

- The assumptions used in the WCS Coalition White Paper (shown in table on left) are typical for a commercial cellular network planning exercise.
- UEs are assumed to be outdoors for purposes of the pathloss estimation, which results in the UL Tx power statistics for the outdoor UE use case being much lower than maximum allowable WCS UE transmit power of 250 mW due to the absence of building penetration loss.
- Shadow fading and Spatial Channel Model were used for dynamic channel response effects.
- Channel estimation and link adaptation were enabled to mimic LTE uplink Sounding Reference Signal (SRS) mechanism, resulting in PRB assignments that adapt to dispersive channel characteristics.



# Summary

- The system level simulation that is the basis of the WCS Coalition White Paper shows UE performance expected from commercial LTE deployments in the 2.3 GHz WCS band.
  - System level simulation is much more detailed than a link level simulation, taking into account additional PHY and MAC layer performance aspects, such as power control, resource scheduling and MCS selection.
  - Additional information can be obtained from the simulation such as PRB distribution and UL transmit power statistics.
- The simulation results presented in the WCS Coalition White Paper show that the UL PRB distribution will approximate a wideband waveform over a short period of time due to the combined effects of the multipath channel and the LTE PHY and MAC implementation.
- UE transmit power levels are typically greatly reduced from the maximum allowable due to lack of building penetration loss for outdoor devices and the need for high system capacity (Mbps/Km<sup>2</sup>), which drives smaller cell sizes.

